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PGES
All-Party Parliamentary Group
for Energy Studies
Founded in 1980

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SC ESNZ Inquiry 7831 A flexible Grid for the future

Call for Evidence 3187 Submission reference OGR643460

Response from All-Party Parliamentary Group for Energy Studies (PGES)

The All-Party Parliamentary Group for Energy Studies (PGES) was formed in 1980 with the aim to inform parliamentarians of the day on the energy issues of the day. We have representation of all major parties from Ian Liddell-Grainger MP who is in the Chair and other Council members.

PGES is the only parliamentary group to embrace all areas of the energy industry, providing a forum for high-level discussions of key energy issues facing the country. Our members include Parliamentarians from both Houses, leading academic institutions and industry representatives ranging from SMEs to multi-national corporations.

Unlike other APPGs, we are not a single-issue lobbying group. Our purpose is to provide valuable insights into energy markets to inform good policy-making without favouring any particular technology or approach.

The new Select Committee has launched four inquiries into the energy sector, presenting an opportunity for PGES to fulfil its objectives. Our Associate Membership, both industrial and academic, has knowledge and experience in all sectors of the Inquiry, which we would like to share.

1. **Does the current national and DNO grid deliver the capacity needed for the future and, if not, what are the solutions?**

Current regulatory frameworks do not equip national and DNO grid operators to meet projected energy demands on their networks as much as it can or other nations allow. It is predicted that by 2050, the UK power grid will need to support twice its current energy demand due to the decarbonisation of transportation and heat.

In late 2022, there were over 176GWi of energy projects, including 80GW of energy storage, waiting to be connected to the grid. A project, which to a large extent aims to produce essential decarbonised energy to achieve net zero targets and break our current exposure to gas, will not be allowed to connect until after 2030.

The UK's reliance on imported fossil fuels is causing an energy cost crisis and security challenge, which is damaging both the economic and social welfare of the country. The piecemeal change being undertaken today is not rapid enough, leaving the UK increasingly vulnerable and now recognised as lagging behind early gains on the climate. A grid that is not keeping up with the demands predictably placed on it stalls the installation of low carbon technology.

Facilitating cross department change will be critical to the success of our net zero ambitions. Collaboration between our Government, including Members of both Houses, our industry regulators, infrastructure developers and financial investors, planners, educational establishment, and crucially the general public is key to our success going forward.

The UK will be undertaking this work in the knowledge that others worldwide are tackling the same problems. No one nation has resolved all the issues around infrastructure investment or the lack of availability of trained personnel and materials to complete the tasks in hand.

The current power grid is still largely managed using worst-case scenario models despite being more dynamic than in the past due to the increasing renewable energy penetration and electrified transport and heat. A comprehensive understanding of the grid's true capacity necessitates a high visibility of all aspects of the power grid, particularly Distributed Energy Resources (DERs)[ii] as evidenced by the UK power outage on 9th August 2019 that was exacerbated by the unexpected disconnection of DERs[iii]. This opacity results in the inability of Transmission System Operators (TSOs) and Distribution Network Operators (DNOs) to proactively build networks ready for 2035/2050.

There are significant delays to construction and delivery for new transmission lines due mostly to regulatory and planning issues. TSOs and DNOs cannot proactively upgrade their networks. Regulatory constraints imposed by Ofgem via its RIIO price control process limit the potential for grid reinforcement and expansion. Essential grid upgrades are restricted by a system flooded with thousands of enquiries to build renewable projects that often fail to materialise.

There is an urgent need to reform of the power grid connection processes to alleviate administrative burdens created by the current "first come first serve" system to enable the grid to make strategic infrastructure investments. Allowing network companies to undertake proactive investments and reduce their current administrative and technical responsibilities should support this.

Difficulties are exacerbated by the inefficient utilisation of engineers to manage constraints arising from the sheer volume of connection enquiries. Many connection proposals are highly interdependent and almost exclusively modelled as bespoke studies by specialist engineers. This is creating a logjam compounded by a skills gap that makes it harder for TSOs and DNOs to look at and fully consider the opportunities and impact from alternative technologies.

Whilst our industry employs some amazingly talented staff the prospect of exponential growth in grid constraints arising from the rise in the adoption of Electric Vehicles (EVs) and heat pumps will not only create more complexity but also create further strain on our human resources. We need to unlock the grid connection regime to get better use of the exceptional talent we currently have and collaborate closer with colleagues in the Department of Education to encourage more to understand the incredible opportunities our industry can offer.

The future grid must be able to support the delivery of the evolution of flexibility markets, positioning the UK as a leader in grid edge flexibility, with strategies like regional balancing and clearer planning for extensive low voltage networks. This will require the delivery of improved grid visibility and observability by deploying more ICT devices and using them effectivelyiv.

Enhancing grid capacity growth by granting network companies more innovation freedom and reducing regulatory barriers will be a fundamental and necessary early deliverable in order to ensure we are on the path to net zero. We must facilitate and stimulate the development of flexibility markets to harness innovation and develop the UK as a world leader in grid edge flex. Regional balancing can better use the capacity that exists and provide clearer national level planning guidance, especially in the millions of km of low voltage networks which will soon be constrained.

2. **Has the organisation of the National Grid proved a barrier to the installation of renewable energy sources, and if so what could be done to remedy this?**

The lack of clarity with respect to roles and responsibilities between the Government, System Operator and Energy Regulator prevents leadership and accountability to finding solutions to issues. There is a clear need for effective TSO-DSOv cooperation going forward as we invest in a new, more dynamic and renewable saturated future operational model.

Whilst operating under its current regulatory framework National Grid may be considered to be facing numerous regulatory barriers limiting its ability to install increasing amounts of much needed renewable energy sources. There are efforts ongoing to address barrier mitigation however progress as always is slow and action slower.

Increased complexity of our power grids is the key reason, due to variability of renewable energy generation and bidirectional power flows that cause more grid congestion and grid frequency variation concerns. Aggravated by the way that grid and DNOs have to respond to, rather than develop for, low carbon technology National Grid needs the ability to manage more efficiently, particularly considering 2035/2050 scenarios.

The National Infrastructure Commission (NIC) could lead development of solutions by identifying critical grid upgrades, expanding holistic network designvi for the whole energy transition not just offshore wind, new strategic substations and bring forward construction to speed up the energy transition. This could be coupled with the development of a new grid connection regime reform for both generators and consumers. This initiative would require the NIC to create a grid connection task force to study the connection processes abroad and deliver a faster, more robust and cost effective process for the UK.

Technical solutions to gain more from existing assets can help to smooth out the variability of renewable energy. Comprising the deployment of advanced monitoring and control systems, communication technologies that allow for real-time coordination between different parts of the power grid for different regions and distribution grids coupled with the increased and enhanced development and deployment of energy storage technologies including hydrogen as an energy storage vector and virtual power plantsvii. Effective TSO-DSO coordination schemes, such as decentralised optimisation and data-driven approachesviii, could be tested and implemented to accelerate renewable energy penetration. Regulatory changes will also be needed to facilitate the proactive integration of renewable energy including creating incentives for renewable energy development, and flexibility of both generation and demand.

3. **Should there be more innovation and devolution in the development of the Grid?**

Technical and regulatory innovations are enablers of grid development and also provide exportable commodities for the UK. Increased innovation and devolution could improve adaption to changing needs, including the pathway to the net zero and ever-increasing extreme weather events. Innovative technologies such as AI and machine learningix could help optimise grid operations, manage renewable energy variability, and predict maintenance needs via digital twinsx.

Decentralisation (e.g., peer-to-peer energy tradingxi, micro grid, energy hubs or smart local energy community) could also allow for more local and grid edgexii control and flexibilityxiii, facilitate the integration of distributed energy resources, and improve grid resiliency.

Innovation will be key in the way planning consents are secured particularly to increase local engagement and increase benefits to those impacted by such developments including moving to a cluster study approach. We need to ensure the best-developed projects are built.

Devolution, leading to important roles for Scotland, Wales and regional assemblies could enable the development of community-centric energy systems, where local communities generate, distribute and consume their own energy, thereby reducing dependency on the large power grid. This could increase further public support for renewable energy and reduce transmission losses. Devolution also requires careful regulation to ensure reliability and fairness, particularly with respect to energy vulnerability and manage the interaction between local grids and the national grid.

4. What changes should be made to the planning system to enable it to increase the use of renewable energy?

To improve the use of renewable energy through the planning system, we need to make 5 major changes. Firstly, strategic zoning can be employed to identify regions optimal for specific renewable technologies like solar and wind, based on comprehensive renewable resource assessments, grid constraints and energy demand growth trends. Secondly, offering pre-approved environmental evaluations can drastically reduce wait times for developers. Regulations need to be adaptive, or at least staggered, depending on renewable energy penetration levels.

Thirdly, an integrated approach to grid planning is crucial, ensuring synchronisation between renewable energy growth and grid expansions, while also making provisions for advanced energy storage, essential for ensuring the stability of power grid with greater level of renewable energy connectionsxiv.

Fourthly, engaging communities plays a pivotal role, as do public consultations and benefit-sharing mechanisms can ease potential opposition and foster a sense of ownership; local energy communities approach turns out to be effectivexv. Lastly, maintaining transparency in every step of planning and decision-making assures all stakeholders, developers, investors, and the public remain informed and aligned with the shared vision of a sustainable future. This transparency includes the publication of data used for planning and decision-making.

5. Is our planning system able to deliver more rapid development of new local infrastructure?

No, because the current planning system was designed with checks to ensure new projects meet environmental, safety, and community requirements. Whilst essential, they inherently slow down the approval and implementation processes. There are multiple additional reasons for delay including resource limitations, the involvement of multiple agencies for making approvals, frequent regulatory changes caused by a lack of longer-term vision, environmental concerns and community oppositions.

We suggest improvements to our Strategic Planning regime by adopting more strategic, long-term planning approaches, which align new infrastructure projects with future growth and development. This can expedite approvals since there becomes a clear overarching vision shared with wider relevant stakeholders.

We need to streamline the permitting process, create a one-stop gateway or fast track for critical infrastructure projects coupled with enhanced and improved collaboration between public and private stakeholders to speed up the planning and implementation phases. The adoption of digital tools and platforms would make the planning process more transparent, accessible, and efficient.

6. Would regional, or nodal, pricing of energy facilitate a more flexible development of Grid infrastructure?

There is no clear evidence that local balancing by pricing will effectively solve supply/demand imbalance in a region-by-region manner. It also creates new problems, such as a lack of fairness and increases the potential of energy vulnerability.

Nodal or zonal pricing can create massive price volatility in certain locations which are not linked to inherent costs of grid upgrades. Public acceptance may therefore be challenging. It could be argued that a zonal/nodal price would more clearly show where congestion is and make the case to build more wires clearer, albeit the information is already pretty clear with a 600-project queue.

Price uncertainty and volatility creates systemic risks to new build generation that will stall investment in generation and potentially storage. The specific risk is that prices for certain infrastructure fall more than others, which creates uncertainty for investment. Uncertainty translates as higher costs of capital which can add 30-50% to the cost of electricity.

Theoretically this approach could give incentives, for generators and customers that can, to change their location, however, is the cost of connection always the top priority? This might relieve the pressures on the most constrained parts of the grid however, these are typically where the best renewable resources are. There is a heated debate about whether those projects would really respond to signals sent by nodal/zonal energy prices particularly if for example they already have planning consents or seabed leases. This approach would in fact shift projects from where the resource is best to ones where it is inefficient. It also reduces the utility of social factors such as community interest/payments from influencing the location of renewable generators.

The time taken to debate and ultimately implement, which could take circa 7 years, would create further uncertainty and deter investment in renewables and potentially the grid.

Locational Marginal Pricing hits the poor the most and there is little evidence showing that it is value for money for all. Whether nodal or zonal, quoting the scale of the challenge combined with a lack of convincing arguments as to why this is going to be beneficial rather than resolving the current problems via charging reform for local constraints market is counter intuitive.

7. **What can be usefully learned from power transmission systems in other countries?**

There are a wide variety of approaches around the world emanating from the maturity of the networks and energy market. For example in some USA states (specifically MISO and DESC) operating cluster studies results in reduced developer risks, improve cost allocation and allows accelerated investment in the grid. On a yearly or biannual basis, all new generators submit requests to get grid connections at the same time. These are reviewed in aggregate and the network company works out the cost and timelines to upgrade the network to support the projects. Grid connection costs and timelines are assigned to projects based on their network impact and then communicated to bidders to accept or /reject. This is repeated over at least two phases until final costs are allocated.

The UK operates on the basis that each project has an individual cost and timelines are assessed, modelled, the scope scrutinised and project usually rejected. The US system reduces the workload for the grid companies and shares the costs out amongst projects, naturally finding efficiencies in both resource and cost

As a further reference, the Netherlands has undertaken a more centralised approach to renewables.

In recent news it appears that Tennet has awarded €23 billion HVDC offshore grid contracts in the Dutch and German North Sea according to Windpower Monthly and are rumoured to have bought all the convertor stations in production. This is a far more centrally planned approach that the UK, but one that puts them in poll position for future North Sea developments.

[i] Queue management: the next step in accelerating grid connections | National Grid ET

[ii] EPSRC project: Virtual Power Plant with Artificial Intelligence for Resilience and Decarbonisation (VPP-WARD), EP/Y005376/1

[iii] Ofgem, 9 August 2019 power outage report, 3 January 2020.

iv M. You, J. Jiang, A. Tonello, T. Doukoglou, & H. Sun (2018). On Statistical Power Grid Observability under Communication Constraints. IET Smart Grid 1(2): 40-47.

[v] The UK system is made up of 3 onshore Transmission Owners (TOs), 6 companies owning 14 distribution networks (DNOs), an increasingly independent transmission system operator (the ESO becoming the FSO) and various offshore OFTOs and interconnector owners.

[vi] https://www.nationalgrideso.com/future-energy/pathway-2030-holistic-network-design

[vii] https://www.ukri.org/news-and-events/responding-to-climate-change/developing-new-behaviours-and-solutions/putting-the-power-in-the-hands-of-households/

[viii] AG Givisiez, K Petrou, LF Ochoa, A Review on TSO-DSO Coordination Models and Solution Techniques, Electric Power Systems Research, 189 (2020) 106659

[ix] W. Hua, J. Jiang, H. Sun, A. Tonello, M. Qadrdan, & J. Wu (2022). Data-driven prosumer-centric energy scheduling using convolutional neural networks. Applied Energy 308: 118361.

[x] M. You, Q. Wang, H. Sun, I. Castro, & J. Jiang (2022). Digital Twins based Day-ahead Integrated Energy System Scheduling under Load and Renewable Energy Uncertainties. Applied Energy 305: 117899.

[xi] W. Hua, J. Jiang, H. Sun, & J. Wu (2020). A Blockchain Based Peer-to-Peer Trading Framework Integrating Energy and Carbon Markets. Applied Energy 279: 115539.

[xii] This could deliver national savings of >£500m (per year or any specific duration) through grid edge flexibility e.g. straight £500 subsidy to any domestic battery that alleviates voltage constraints

[xiii] W. Hua, H. Xiao, W. Pei, W.-Y. Chiu, J. Jiang, Jing, H. Sun, & P. Matthews (2023). Transactive Energy and Flexibility Provision in Multi-microgrids using Stackelberg Game. CSEE Journal of Power and Energy Systems 9(2): 505-515.

[xiv] Professor JV Milanovic, et al. Role of energy storage in enhancing operation and stability performance of sustainable power systems (RESTORES), EPSRC EP/L014351/1.

[xv] Professor S McArthur, et al. Energy Revolution Research Consortium - Core - EnergyREV, EPSRC EP/S031863/1